E/ECE/324
E/ECE/TRANS/505 } Add.8/Rev.2/Amend.1

7 July 1999

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS */

(Revision 2, including the amendments entered into force on 16 October 1995)

Addendum 8: Regulation No. 9

Revision 2 - Amendment 1

06 series of amendments - Date of entry into force: 8 March 1999

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF CATEGORY L2, L4 AND L5 VEHICLES WITH REGARD TO NOISE

UNITED NATIONS

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*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

GE.99- 22343

Title, amend to read:

"UNIFORM PROVISIONS CONCERNING THE APPROVAL OF CATEGORY L2, L4 and L5 VEHICLES WITH REGARD TO NOISE"

Contents, Annexes, insert the title of a new annex 4, to read:

"Annex 4: Specifications for the test site"

Text of the Regulation,

General amendment: throughout the text of the Regulation, the words "silencing system(s) ..." should be replaced by "exhaust or silencing system(s) ..."

Paragraph 2.1., amend to read:

"2.1. 'Approval of a vehicle' means the approval of a vehicle type with regard to the noise level and the original exhaust system as a technical unit;"

Paragraph 2.2.3., amend to read:

"2.2.3. the type of engine (positive ignition or compression ignition; reciprocating or rotary piston; number and capacity of cylinders; number and type of carburettors or injection systems, arrangement of valves; maximum net power and corresponding engine speed).

For rotary piston engines, the cubic capacity should be taken to be double of the volume of the chamber;"

Insert a new paragraph 2.2.5., to read:

"2.2.5. The number, type and arrangement of exhaust systems."

Insert a new paragraph 2.3.1., to read:

"2.3.1. 'Original exhaust or silencing system' means a system of the type with which the vehicle is equipped on acceptance or extension of acceptance. It may be part of the original equipment or a replacement."

Paragraphs 4.1. to 4.1.2., amend to read:

"4.1. The components of the silencing system shall bear an international approval mark consisting of:

4.1.1. the "E" mark described in paragraph 5.4.1.; and

4.1.2. the markings described in paragraph 5.4.2."

Paragraph 5.2., amend to read:

"5.2. An approval number shall be assigned to each type approved. Its first two digits (at present 06 corresponding to the 06 series of amendments which entered into force on ...) shall indicate the series of amendments ..."

Paragraph 5.4.1., amend to read:

"..... 24 for Ireland, ... 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33-36 (vacant), 37 for Turkey, 38-39 (vacant), 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol) and 43 for Japan. Subsequent numbers ..... to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers ....."

Paragraph 6.2.1.3., amend the value of "82 dB(A)" to read "80 dB(A) for categories L4 and L5 and 76 dB(A) for category L2".

Paragraph 8., amend to read:

"8. CONFORMITY OF PRODUCTION

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2), with the following requirements:"

Paragraph 8.2., amend to read:

"... from the series. Production shall be deemed to conform to the requirements of this Regulation if the levels measured using the method described in the annex do not exceed by more than 3 dB(A) the value measured on acceptance, or by more than 1 dB(A) the limits prescribed in paragraph 6.2.1.3."

Paragraph 11., amend to read:

"11. TRANSITIONAL PROVISIONS

11.1. As from the official date of entry into force of the 06 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approval under this Regulation as amended by the 06 series of amendments.

11.2. As from 17 June 1999, Contracting Parties applying this Regulation shall grant ECE approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 06 series of amendments.

11.3. Contracting Parties applying this Regulation shall not refuse to grant extensions of approval under preceding series of amendments to this Regulation.

11.4. Contracting Parties applying this Regulation shall continue to grant approvals to those types of vehicle which conform to the requirements of this Regulation as amended by preceding series of amendments until 17 June 1999 only.

11.5. ECE approvals granted under this Regulation earlier than 17 June 1999 and all extensions of such approvals, including those to a preceding series of amendments to this Regulation granted subsequently, shall remain valid indefinitely. When the vehicle type approved under preceding series of amendments meets the requirements of this Regulation as amended by the 06 series of amendments, the Contracting Party which granted the approval shall notify the other Contracting Parties applying this Regulation thereof.

11.6. No Contracting Party applying this Regulation shall refuse national type approval of a vehicle type approved under the 06 series of amendments to this Regulation or meeting the requirements thereof.

11.7. Until 17 June 2003, no Contracting Party applying this Regulation shall refuse national type approval of a vehicle type approved under preceding series of amendments to this Regulation.

11.8. Starting 17 June 1999, Contracting Parties applying this Regulation may refuse first national registration (first entry into service) of a vehicle which does not meet the requirements of the 06 series of amendments to this Regulation."

Annex 1, amend to read:

".....

Approval No: ... Extension No: ...

1. Trade name or mark of vehicle .....

2. Vehicle type .....

2.1. Variant(s) (as necessary):

2.2. Version(s) (as necessary):

.....

15. Brief description of the original exhaust system:

15.1. Type(s) of original exhaust system(s):

15.2. Type(s) of intake system(s) (if necessary in order to observe the noise level limit):

.....

(Footnotes not modified)"

Annex 2, in the examples of Model A and Model B approval marks and in the text below, replace the approval number "052439" by "062439" and the words "05 series of amendments" by "06 series of amendments".

Annex 3.

Paragraphs 1.1. and 1.2., amend to read:

"1.1. The apparatus used for measuring the sound level shall be a precision sound-level meter of the type described in International Electrotechnical Commission (IEC) publication No. 179 "Precision sound-level meters", second edition. Measurements shall be carried out using the "fast" response of the sound-level meter and the "A" weighting also described in that publication.

1.2. At the beginning and end of each series of measurements the sound-level meter shall be calibrated in accordance with the manufacturer's instructions, using an appropriate sound source (e.g. pistonphone)."

Insert a new paragraph 1.3., to read:

"1.3. Speed measurements

The engine speed and vehicle velocity on the test track shall be determined with an accuracy of ± 3%."

Paragraph 2.1., amend to read:

"2.1. Condition of the vehicle

During the measurements, the vehicle shall be in running order (including coolant, oils, fuel, tools, spare wheel and driver). Before the measurements are made the vehicle shall be brought to the normal operating temperature.

The measurements shall be made with the vehicle unladen and without trailer or semi-trailer."

Paragraph 2.2., amend to read:

"2.2. The test site shall consist of a central acceleration track surrounded by a substantially level test area. The test track shall be level; the track surface shall be dry and so designed that tyre noise remains low.

On the test site, free sound field conditions shall be maintained to within ± 1 dB between the sound source placed in the middle of the acceleration section and the microphone. This condition shall be deemed to be met if there are no large sound-reflecting objects such as fences, rocks, bridges or buildings within 50 metres of the centre of the acceleration section. The surface of the test track shall conform to the requirements of annex 4.

No obstacle likely to affect the sound field shall be close to the microphone and no one shall come between the microphone and the sound source. The observer taking the measurements shall take up position so as to avoid influencing the metre readings."

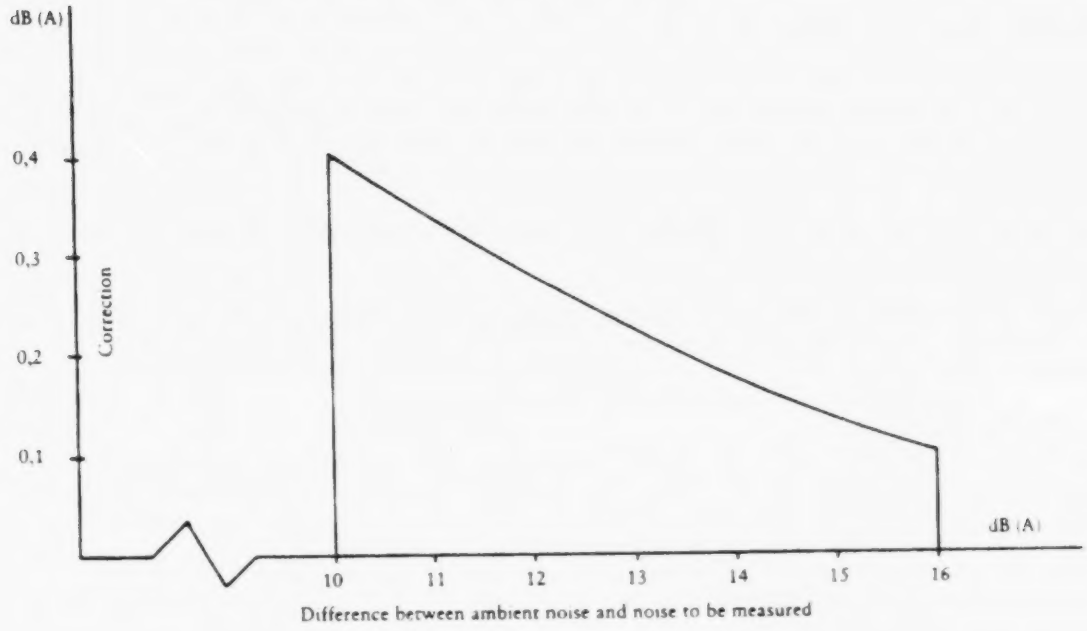
Paragraph 2.3., amend to read:

"2.3. Miscellaneous

Measurements shall not be made in poor weather conditions. Precautions shall be taken to ensure that readings are not influenced by wind gusts.

For measurement purposes, the weighted sound-level (A) of sound sources other than on the test vehicle and the sound-level produced by the effect of the wind shall be at least 10 dB(A) below the noise-level produced by the vehicle. The microphone may be fitted with a suitable wind-guard, provided that its influence on the sensitivity and directional characteristics of the microphone are taken into account.

If the difference between ambient and measured noise-levels is between 10 and 16 dB(A), the appropriate figure shall be subtracted from the value recorded by the sound-level metre, in accordance with the following graph:



Paragraph 3.1.1.1., amend to read:

"3.1.1.1. The maximum weighted sound-level (A), expressed in decibels (dB), shall be measured as the vehicle is driven between lines AA' and BB' (fig. 1). The measurement shall be invalid if an abnormal discrepancy between the peak value and the general sound-level is recorded.

At least two measurements shall be made on each side of the vehicle.

Preliminary measurements may be made for adjustment purposes, but shall be disregarded."

Paragraph 3.1.1.5., amend to read:

"3.1.1.5. The values, rounded off to the nearest whole decibel, shall be taken from the measuring apparatus. If the figure following the decimal point is between 0 and 4, the total is rounded down and if between 5 an 9, it is rounded up.

Only values which are obtained from two consecutive measurements on the same side of the vehicle, and do not differ by more than 2 dB(A), shall be accepted.

The result of the measurement shall be determined in accordance with paragraph 4 of this annex."

Paragraph 3.1.2.2., amend to read:

"... the first higher gear which ensures that this regime is no longer exceeded up to the line BB' of the measurement area should be used instead of the second or third gear. Auxiliary ..."

Paragraphs 3.2. to 3.2.3.2., replace by the following text and insert new paragraphs 3.2.3.3. to 3.2.4.4.:

"3.2. Measurement of noise of stationary vehicles (for testing of vehicles in service)

3.2.1. Acoustic pressure level close to vehicles

In addition, so as to facilitate the subsequent testing of vehicles in service, the acoustic pressure level shall be measured near the outlet of the exhaust system (silencing system), in conformity with the requirements set out below, and the result of the measurement shall be included in the test report prepared for the issuance of the document referred to in annex 1.

3.2.2. Measuring instruments

The measurements shall be made using a precision sound-level meter in accordance with paragraph 1 of this annex.

3.2.3. Conditions for measurements

3.2.3.1. Condition of the vehicle

Before the measurements are started, the vehicle engine shall be brought to its normal operating temperature. If the vehicle is equipped with automatic fans, no adjustment shall be made to them during the measurement of the noise level.

While measurements are being made, the gear lever shall be in neutral. If the transmission cannot be disconnected, the drive wheel of the vehicle should be allowed to run under no-load conditions by, for example, placing the vehicle on a support or on rollers.

3.2.3.2. Test site

Any area not subject to major acoustic perturbations may be used as a test site. Level areas covered with concrete, asphalt or some other hard material and are highly reflective are suitable; surfaces consisting of earth which has been tamped down must not

be used. The test site shall have at least the dimensions of a rectangle the sides of which shall be 3 metres from the outline of the vehicle (excluding handlebars). No significant obstacle such as a person other than the observer and the driver shall be within this rectangle.

The vehicle shall be placed within the above-mentioned rectangle in such a way that the measuring microphone is at least one metre from any stone edging.

3.2.3.3. Miscellaneous

Instrument readings caused by ambient or wind noise shall be at least 10 dB(A) less than the noise level to be measured. The microphone may be fitted with a suitable wind-guard provided that its effect on microphone sensitivity is taken into account.

3.2.4. Method of measurement

3.2.4.1. Number of measurements

At least three measurements shall be made at each measurement point. The measurements shall be considered valid only if the difference between the results of three consecutive measurements is not more than 2dB(A). The highest value obtained from these three measurements shall be accepted.

3.2.4.2. Position of the microphone

The height of the microphone above the track surface shall be the same as that of the exhaust outlet, but in any case shall not be less than 0.2 m. The microphone diaphragm shall be directed towards the exhaust outlet and placed at a distance of 0.5 m from it. The maximum sensitivity axis of the microphone shall be parallel to the track surface and form an angle of 45° ± 10° with the vertical plane of the direction of the exhaust outlet.

The vertical placement of the microphone shall be on the side which affords the maximum distance between the microphone and the outline of the vehicle (excluding handlebars). If the exhaust system comprises a number of outlets whose centres are not more than 0.3 m apart, the microphone shall be directed towards the outlet closest to the vehicle outline (excluding handlebars) or towards the outlet which is highest above the track surface. If the outlet centres are more than 0.3 m apart, separate measurements shall be made at each exhaust outlet and only the highest value shall be accepted.

3.2.4.3. Operating conditions

The engine speed shall be held steady at one of the following values:

1/2 S if S exceeds 5,000 rpm;
3/4 S if S does not exceed 5,000 rpm,

where S is the engine speed at which the engine produces its maximum power.

Once the steady speed is obtained, the throttle control shall be quickly returned to idling position. The sound-level shall be measured for a brief period when the steady speed is being maintained and throughout deceleration, and the valid result of the measurement shall be that corresponding to the maximum reading on the sound-level meter.

3.2.4.4. The values, rounded off to the nearest whole decibel, shall be read from the measuring apparatus. If the figure following the decimal point is between 0 and 4, the total is rounded down and if between 5 and 9, it is rounded up.
Only values which are obtained from three consecutive measurements which do not differ by more than 2 dB(A) shall be accepted. The highest of the three measurements will constitute the test result."

Paragraph 4., amend to read:

"4. INTERPRETATION OF RESULTS FOR VEHICLES IN MOTION

The values taken shall be rounded off to the nearest whole decibel. If the figure following the decimal point is between 0 and 4, the total is rounded down and if between 5 an 9, it is rounded up.

Only the values of readings obtained from two consecutive measurements made on the same side of the vehicle and not differing by more than 2 dB(A) shall be accepted.

To allow for lack of precision in the readings, the result of each measurement shall be taken as equal to the value obtained, less 1 dB(A).

If the average of the four readings does not exceed the maximum permissible level for the category to which the tested vehicle belongs, the limit specified in paragraph 6.2.1.3. shall be deemed as being complied with. This average value shall constitute the test result."

Insert a new paragraph 5., as follows:

"5. ORIGINAL EXHAUST (SILENCING) SYSTEM

5.1. Requirements for silencers containing absorbent fibrous materials

5.1.1. Fibrous absorbent material must be asbestos-free and may be used in the construction of silencers only if suitable devices ensure that the fibrous absorbent material is kept in place for the whole time that the silencer is being used and it meets the requirements of any one of paragraphs 5.1.2., 5.1.3. or 5.1.4.

5.1.2. After removal of the fibrous material, the sound-level must conform to the requirements of paragraph 6.2.1.3.

5.1.3. The fibrous absorbent material may not be placed in those parts of the silencer through which the exhaust gases pass and must conform to the following requirements:

5.1.3.1. The material shall be heated at a temperature of 650 ± 5 °C for four hours in a furnace without reduction in the average length, diameter or bulk density of the fibre;

5.1.3.2. After heating at 650 ± 5 °C for one hour in a furnace, at least 98% of the material must be retained in a sieve of nominal aperture size 250 µm conforming to ISO standard 3310/1 when tested in accordance with ISO standard 2599;

5.1.3.3. The loss in weight of the material must not exceed 10.5% after soaking for 24 hours at 90 ± 5 °C in a synthetic condensate of the following composition:

1 N hydrobromic acid (HBr)	10 ml
1 N sulphuric acid (H_2SO_4)	10 ml
Distilled water to make up to	1,000 ml

Note: The material must be washed in distilled water and dried for one hour at 105 °C before weighing.

5.1.4. Before the system is tested in accordance with paragraph 3, it must be put into a normal state for road use by one of the following methods:

5.1.4.1. Conditioning by continuous road operation

5.1.4.1.1. Depending on the category of vehicle, the minimum distances to be completed during conditioning shall be:

Category of vehicle according to cylinder capacity in cm^3		Distance (km)
1. 250		4 000
2. > 250	500	6 000
3. > 500		8 000

5.1.4.1.2. 50% ± 10% of this conditioning cycle shall consist of town driving and the remainder of long-distance runs at high speed; the continuous road cycle may be replaced by a corresponding test-track programme;

5.1.4.1.3. The two speed regimes must be alternated at least six times;

5.1.4.1.4. The complete test programme must include a minimum of 10 breaks of at least 3 hours' duration in order to reproduce the effects of cooling and condensation.

5.1.4.2. Conditioning by pulsation

5.1.4.2.1. The exhaust system or components thereof must be fitted to the vehicle or to the engine.

In the former case, the vehicle must be mounted on a roller dynamometer. In the second case, the engine must be mounted on a test bench.

The test apparatus, a detailed diagram of which is shown in Figure 3, shall be fitted at the outlet of the exhaust system. Any other apparatus providing equivalent results shall be acceptable.

5.1.4.2.2. The test equipment must be adjusted so that the flow of exhaust gases is alternately interrupted and restored 2,500 times by a rapid-action valve.

5.1.4.2.3. The valve must open when the exhaust gas back-pressure, measured at least 100 mm downstream of the intake flange, reaches a value of between 0.35 and 0.40 bar. Should such a figure be unattainable because of the engine characteristics, the valve must open when the gas back-pressure reaches a level equivalent to 90% of the maximum that can be measured before the engine stops. It must close when this pressure does not differ by more than 10% from its stabilized value with the valve open.

5.1.4.2.4. The time-delay switch must be set for the duration of exhaust gases calculated on the basis of the requirements of paragraph 5.1.4.2.3. above.

5.1.4.2.5. Engine speed must be 75% of the speed (S) at which the engine develops maximum power.

5.1.4.2.6. The power indicated by the dynamometer must be 50% of the full-throttle power measured at 75% of engine speed (S).

5.1.4.2.7. Any drainage holes must be closed off during the test.

5.1.4.2.8. The entire test must be completed within 48 hours. If necessary, a cooling period must be allowed after each hour.

5.1.4.3. Conditioning on a test bench

5.1.4.3.1. The exhaust system must be fitted to an engine representative of the type fitted to the vehicle for which the system is designed, and mounted on a test bench.

5.1.4.3.2. Conditioning shall consist of the specified number of test-bench cycles for the category of vehicle for which the exhaust system was designed. The number of cycles for each vehicle category shall be:

Category of vehicle according to cylinder capacity in cm^3		Number of cycles
1. ≤ 250		6
2. > 250	≤ 500	9
3. > 500		12

5.1.4.3.3. Each test-bench cycle must be followed by a break of at least six hours in order to reproduce the effects of cooling and condensation.

5.1.4.3.4. Each test-bench cycle shall consist of six phases. The engine conditions for, and the duration of, each phase shall be:

Phase	Conditions	Duration of phase	
		Engines of less than 250 cm^3	Engines of 250 cm^3 or more
		(min.)	(min.)
1	Idling	6	6
2	25% load at 75% of S	40	50
3	50% load at 75% of S	40	50
4	100% load at 75% of S	30	10
5	50% load at 100% of S	12	12
6	25% load at 100% of S	22	22
	Total time	2 hours 30 mins	2 hours 30 mins

5.1.4.3.5. During this conditioning procedure, at the request of the manufacturer, the engine and the silencer may be cooled in order that the temperature recorded at a point not more than 100 mm from the exhaust gas outlet does not exceed that measured when the vehicle is running at 110 km/h or 75% of S in top gear. The engine and/or vehicle speeds shall be determined to within ± 3%.

5.2. Diagram and markings

5.2.1. The diagram and a dimensioned cross-section of the silencer shall be annexed to the document mentioned in Appendix 1A.

5.2.2. All original silencing systems shall be marked with an "E" followed by the identification number of the approving country. This reference shall be clearly legible and indelible and shall also be visible after mounting.

5.2.3. Any packaging of original replacements for exhaust or silencing systems shall be marked legibly with the words "original part" and the make and type reference integrated together with the "E" mark and also the reference of the country of origin.

5.3. Intake silencers

If the engine intake has to be fitted with an air filter and/or intake silencer in order to comply with the permissible sound level, the filter and/or silencer shall be regarded as part of the silencer and the requirements of paragraphs 5.1. and 5.2. shall also be applicable to them."

Annex 3 - Appendix, amend to read:

"Annex 3 - Appendix

Figure 1

Positions for testing the vehicle in motion

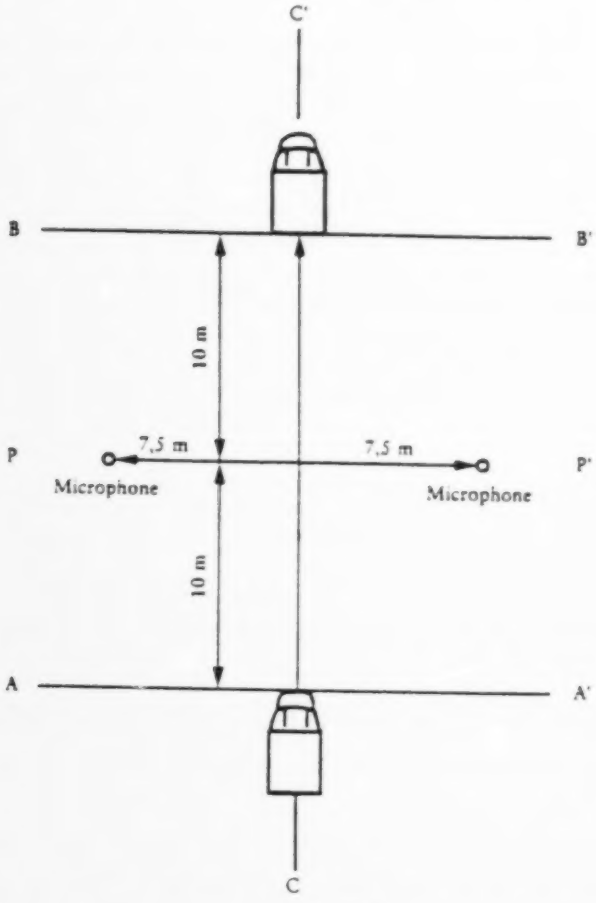
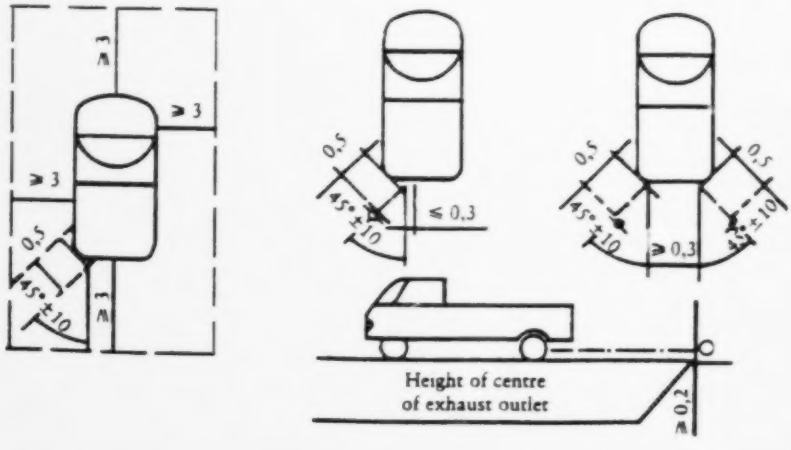


Figure 2

Positions for testing the stationary vehicle



Test apparatus for conditioning by pulsation

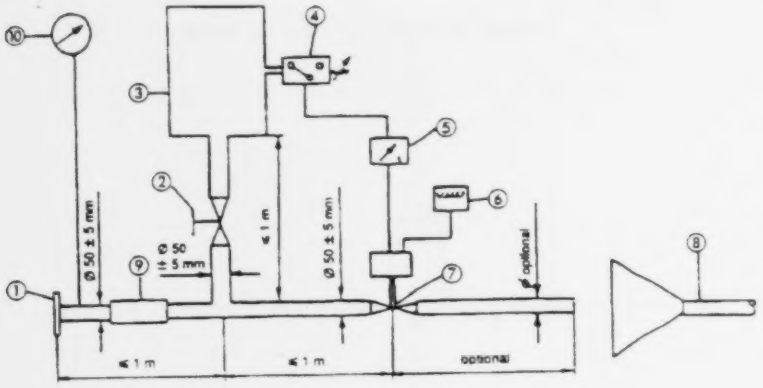


Figure 3

1. Inlet flange or sleeve for connection to the rear of the test exhaust system.

2. Hand-operated regulating valve.

3. Compensating reservoir with a maximum capacity of 40 l and a filling time of not less than one second.

4. Pressure switch with an operating range of 0.05 to 2.5 bar.

5. Time delay switch.

6. Pulse counter.

7. Quick-acting valve, such as exhaust brake valve 60 mm in diameter, operated by a pneumatic cylinder with an output of 120 N at 4 bar. The response time, both when opening and closing, must not exceed 0.5 seconds.

8. Exhaust gas evacuation.

9. Flexible pipe.

10. Pressure gauge."

Insert a new annex 4, to read:

"Annex 4

SPECIFICATIONS FOR THE TEST SITE

1. Introduction

This annex describes the specifications relating to the physical characteristics and the laying of the test track. These specifications based on a special standard 1/ describe the required physical characteristics as well as the test methods for these characteristics.

2. Required characteristics of the surface

A surface is considered to conform to this standard provided that the texture and voids content or sound absorption coefficient have been measured and found to fulfill [all] the requirements of paragraphs 2.1. to 2.4. below and provided that the design requirements (para. 3.2.) have been met.

2.1. Residual voids content

The residual voids content, V_C, of the test track paving mixture shall not exceed 8%. For the measurement procedure, see paragraph 4.1.

2.2. Sound absorption coefficient

If the surface fails to conform to the residual voids content requirement, the surface is acceptable only if its sound absorption coefficient, α 0.10. For the measurement procedure, see paragraph 4.2. The requirement of paragraphs 2.1. and 2.2. is met also if only sound absorption has been measured and found to be α 0.10.

Note: The most relevant characteristic is the sound absorption, although the residual voids content is more familiar among road constructors. However, sound absorption needs to be measured only if the surface fails to comply with the voids requirement. This is because the latter is connected with relatively large uncertainties in terms of both measurements and relevance and some surfaces therefore may be rejected erroneously on the basis of the voids measurement only.

1/ ISO 10844:1994

2.3. Texture depth

The texture depth (TD) measured according to the volumetric method (see para. 4.3. below) shall be:

TD 0.4 mm

2.4. Homogeneity of the surface

Every practical effort shall be made to ensure that the surface is made to be as homogeneous as possible within the test area. This includes the texture and voids content, but it should also be observed that if the rolling process results in more effective rolling at some places than at others, the texture may be different and unevenness causing bumps may also occur.

2.5. Period of testing

In order to check whether the surface continues to conform to the texture and voids content or sound absorption requirements stipulated in this standard, periodic testing of the surface shall be done at the following intervals:

(a) For residual voids content or sound absorption:

when the surface is new;
if the surface meets the requirements when new, no further periodical testing is required. If it does not meet the requirement when it is new, it may do so later because surfaces tend to become clogged and compacted with time.

(b) For texture depth (TD):

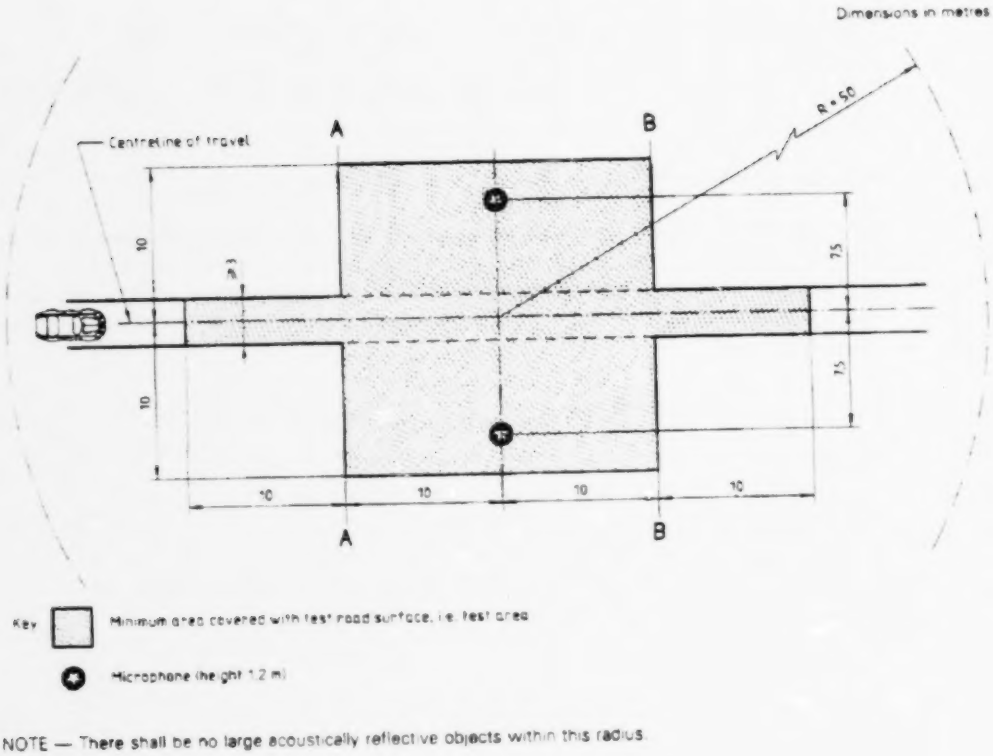
when the surface is new;
when the noise testing starts (NB: not before four weeks after laying);
then every 12 months.

3. Test surface design

3.1. Area

When designing the test track layout it is important to ensure that, as a minimum requirement, the area traversed by the vehicles running through the test strip is covered with the specified test material with suitable margins for safe and practical driving. This will require the width of the track to be at least 3 m and the length of the track to extend beyond lines AA and BB by at least 10 m at either end. Figure 1 shows a plan of a suitable test site and indicates the minimum area which shall be machine laid and machine compacted with the specified test surface material. According to annex 3,

paragraph 3.1.1.1., measurements have to be made on each side of the vehicle. This can be done either by measuring with two microphone locations (one on each side of the track) and driving in one direction, or measuring with a microphone only on one side of the track but driving the vehicle in two directions. If the former method is used, then there are no surface requirements on that side of the track where there is no microphone.



NOTE — There shall be no large acoustically reflective objects within this radius.

Figure 1: Minimum requirement for test surface area. The shaded part is called "Test Area".

3.2. Design and preparation of the surface

3.2.1. Basic design requirements

The test surface shall meet four design requirements:

3.2.1.1. It shall be a dense asphaltic concrete.

3.2.1.2. The maximum chipping size shall be 8 mm (tolerances allow from 6.3 to 10 mm).

3.2.1.3. The thickness of the wearing course shall be ≥ 30 mm.

3.2.1.4. The binder shall be a straight penetration grade bitumen without modification.

3.2.2. Design guidelines

As a guide to the surface constructor, an aggregate grading curve which will give desired characteristics is shown in Figure 2. In addition, Table 1 gives some guidelines for obtaining the desired texture and durability. The grading curve fits the following formula:

$$P\ (\%\ \text{passing}) = 100 \cdot (d/d_{max})^{1/2}$$

where:

d = square mesh sieve size, in mm
d_{max} = 8 mm for the mean curve
d_{max} = 10 mm for the lower tolerance curve
d_{max} = 6.3 mm for the upper tolerance curve

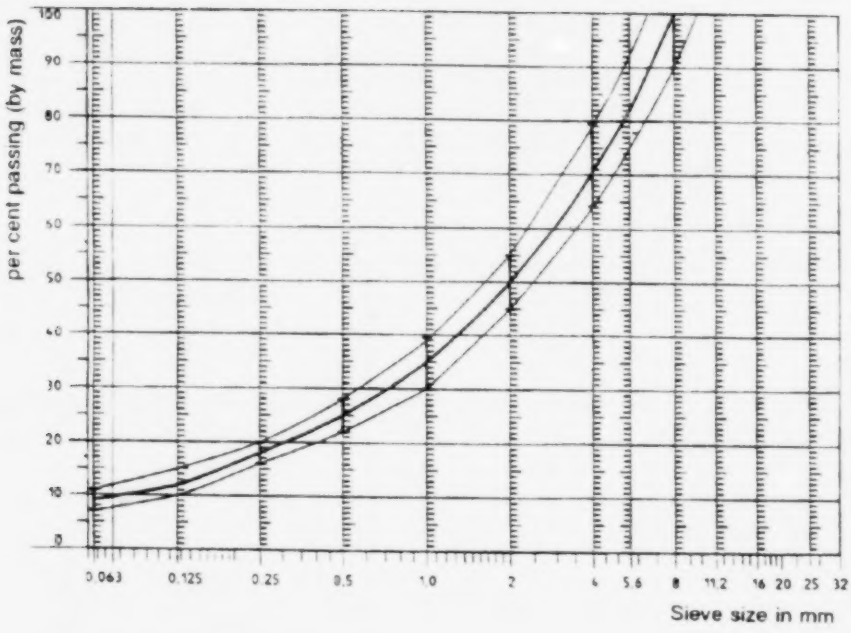


Figure 2: Grading curve of the aggregate in the asphaltic mix with tolerances.

In addition to the above, the following recommendations are given:

(a) The sand fraction (0.063 mm < square mesh sieve size < 2 mm) shall include no more than 55% natural sand and at least 45% crushed sand;

(b) The base and sub-base shall ensure a good stability and evenness, according to best road construction practice;

(c) The chippings shall be crushed (100% crushed faces) and of a material with a high resistance to crushing;

(d) The chippings used in the mix shall be washed;

(e) No extra chippings shall be added onto the surface;

(f) The binder hardness expressed as PEN value shall be 40-60, 60-80 or even 80-100 depending on the climatic conditions of the country. The rule is that as hard a binder as possible shall be used, provided this is consistent with common practice;

(g) The temperature of the mix before rolling shall be chosen so as to achieve by subsequent rolling the required voids content. In order to increase the probability of satisfying the specifications of paragraphs 2.1. to 2.4. above, the compactness shall be studied not only by an appropriate choice of mixing temperature, but also by an appropriate number of passings and by the choice of compacting vehicle.

Table 1: Design guidelines

	Target values		Tolerances
	By total mass of mix	By mass of the aggregate	
Mass of stones, square mesh sieve (SM) > 2 mm	47.6 %	50.5 %	± 5
Mass of sand 0.063 < SM < 2 mm	38.0 %	40.2 %	± 5
Mass of filler SM < 0.063 mm	8.8 %	9.3 %	± 2
Mass of binder (bitumen)	5.8 %	N.A.	± 0.5
Max. chipping size	8 mm		6.3 - 10
Binder hardness	(see para. 3.2.2. (f))		
Polished stone value (PSV)	> 50		
Compactness, relative to Marshall compactness	98 %		

4. Test method

4.1. Measurement of the residual voids content

For the purpose of this measurement, cores have to be taken from the track in at least four different positions which are equally distributed in the test area between lines AA and BB (see Figure 1). In order to avoid inhomogeneity and unevenness in the wheel tracks, cores should not be taken in wheel tracks themselves, but close to them. Two cores (minimum) should be taken close to the wheel tracks and one core (minimum) should be taken approximately midway between the wheel tracks and each microphone location.

If there is a suspicion that the condition of homogeneity is not met (see para. 2.4.), cores shall be taken from more locations within the test area. The residual voids content has to be determined for each core, then the average value from all cores shall be calculated and compared with the requirement of paragraph 2.1. In addition, no single core shall have a voids value which is higher than 10%. The test surface constructor is

reminded of the problem which may arise when the test area is heated by pipes or electrical wires and cores must be taken from this area. Such installations must be carefully planned with respect to future core drilling locations. It is recommended that a few locations of size approximately 200 x 300 mm should be left where there are no wires/pipes or where the latter are located deep enough in order not to be damaged by cores taken from the surface layer.

4.2. Sound absorption coefficient

The sound absorption coefficient (normal incidence) shall be measured by the impedance tube method using the procedure specified in ISO/DIS 10 534: "Acoustics - Determination of sound absorption coefficient and impedance by a tube method".

Regarding test specimens, the same requirements shall be followed as regarding the residual voids content (see para. 4.1.).

The sound absorption shall be measured in the range between 400 Hz and 800 Hz and in the range between 800 Hz and 1,600 Hz (at least at the centre frequencies of third octave bands) and the maximum values shall be identified for both of these frequency ranges.

Then these values, for all test cores, shall be averaged to constitute the final result.

4.3. Volumetric macrotexture measurement

For the purpose of this standard, texture depth measurements shall be made on at least 10 positions evenly spaced along the wheel tracks of the test strip and the average value taken to compare with the specified minimum texture depth. For the description of the procedure see standard ISO 10844:1994.

5. Stability in time and maintenance

5.1. Age influence

In common with any other surfaces, it is expected that the tyre/road noise level measured on the test surface may increase slightly during the first 6-12 months after construction.

The surface will achieve its required characteristics not earlier than four weeks after construction. The influence of age on the noise from trucks is generally less than on noise from cars.

The stability over time is determined mainly by the polishing and compaction by vehicles driving on the surface. It shall be periodically checked as stated in paragraph 2.5.

5.2. Maintenance of the surface

Loose debris or dust which could significantly reduce the effective texture depth must be removed from the surface. In countries with winter climates, salt is sometimes used for de-icing. Salt may alter the surface temporarily or even permanently in such a way as to increase noise, and is therefore not recommended.

5.3. Repaving the test area

If it is necessary to repave the test track, it is usually unnecessary to repave more than the test strip (of 3 m width in Figure 1) where vehicles are driving, provided the test area outside the strip met the requirement of residual voids content or sound absorption when it was measured.

6. Documentation of the test surface and of tests performed on it

6.1. Documentation of the test surface

The following data shall be given in a document describing the test surface:

6.1.1. The location of the test track.

6.1.2. Type of binder, binder hardness, type of aggregate, maximum theoretical density of the concrete (D_R), thickness of the wearing course and grading curve determined from cores from the test track.

6.1.3. Method of compaction (e.g. type of roller, roller mass, number of passes).

6.1.4. Temperature of the mix, temperature of the ambient air and wind speed during laying of the surface.

6.1.5. Date when the surface was laid and name of the contractor.

6.1.6. All test results or at least the latest test result, including:

6.1.6.1. The residual voids content of each core;

6.1.6.2. The locations in the test area from where the cores for voids measurements have been taken;

6.1.6.3. The sound absorption coefficient of each core (if measured). Specify the results both for each core and each frequency range, as well as the overall average;

6.1.6.4. The locations in the test area from where the cores for absorption measurement have been taken;

6.1.6.5. Texture depth, including the number of tests and standard deviation;

6.1.6.6. The institution responsible for tests according to paragraphs 6.1.6.1. and 6.1.6.2. and the type of equipment used;

6.1.6.7. Date of the test(s) and date when the cores were taken from the test track.

6.2. Documentation of vehicle noise tests conducted on the surface

In the document describing the vehicle noise test(s) it should be stated whether all the requirements of this standard were fulfilled or not. Reference shall be given to a document according to paragraph 6.1. describing the results which verify this."